IMPACT ON GROUNDWATER AND SOIL DUE TO SOLID WASTE DUMP

A CASE STUDY OF S. BINGIPUR IN BANGALORE

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Abstract- Municipal Solid Waste Management has become one of the major problems in urban and semi-urban areas. Improper MSW disposal and management causes all types of pollution: air, soil, and water. Indiscriminate dumping of wastes contaminates surface and ground water supplies. Health and safety issues also arise from open dumping. The report starts with various approaches to manage municipal solid waste and a plan to implement an integrated solid waste management for a city. Solid wastes have potential for causing serious adverse impact on the environment. Ground water & Surface water Contamination, Land Pollution, and Air Quality Deterioration. Leachate is a toxic liquid that seeps through solid waste in a land fill. This process extracts soluble dissolved and suspended materials from the waste. It contains bacteria, toxic substances, heavy metals, etc . The impact assessment of the open dumping was assessed by collecting and analyzing ground water and soil (within 5 km of the site) around S Bingipur village dump yard in Bangalore city. The focus of this study is to assess the contribution of waste dumping in soil contamination and in groundwater pollution. Collected surface soil samples from the open waste dumping area and controlled site (away from dumping yard) were examined and found variation in the soil composition. On the other hand, ground water samples were collected from the nearby village bore wells and lake, were analyzed and observed contamination of groundwater up to certain limit. This paper presents the impact of open dumping of solid waste on surrounding water and soil.

Index Terms- Municipal Solid Waste Management, Soil & Groundwater pollution, open dumping and Landfill, Leachate

I. INTRODUCTION

The threat of environmental pollution has been remaining the human world and is still growing fast due to excessive population growth in developing countries. Municipal solid waste (MSW) normally termed as garbage or trash is an unavoidable consequence of human activity. Population growth and economic development lead to enormous amounts of solid waste generation by the dwellers of urban areas. Urban MSW is usually generated from human settlements, small industries and commercial activities .Solid waste from hospitals and clinics is an additional source of MSW. Most of the countries do not have any specific technique of managing hospital and clinical wastes. So, they are mixed with MSW and pose a threat to human population and surrounding environment. Unsuitable disposal of MSW causes all types of pollution: air, soil, and water. Indiscriminate dumping of wastes contaminates surface and ground water supplies. In urban areas, MSW clogs drains, creating stagnant water for insect breeding and floods during rainy seasons. Open burning of MSW contributes significantly to urban air pollution. Open dumping is quite common in developing countries due to low budget available for waste disposal. It also poses serious threat to groundwater. Health and safety issues also arise from improper MSWM. Insect and rodent vectors are attracted to the waste and can spread diseases such as cholera and dengue fever. Using water polluted by MSW for bathing, food, irrigation and drinking water can also expose individuals to disease organisms and other contaminants. In India, dumping on land is the most common method of waste disposal, because it is the cheapest method of waste disposal. Still, this method requires large area and proper drainage. The land disposal of municipal and industrial solid waste is potential cause of groundwater contamination. Unscientifically managed dumping yards are prone to groundwater contamination because of leachate production. Leachate is the liquid that seeps from solid wastes or other medium and have extracts with dissolved or suspended materials from it.

The volume of leachate depends principally on the area of the landfill, the meteorological and hydro-geological factors and effectiveness of capping. It is essential that the volume of leachate generated be kept to a minimum and ensures that the access of groundwater and surface water is minimized and controlled. The volume of leachate generated is therefore expected to be very high in humid regions with high rainfall, or high run off and shallow water table. Leachate from the solid waste dump has a significant effect on the chemical properties as well as the geotechnical properties of the soil. Leachate can modify the soil properties and significantly alter the behavior of soil.

The present study has been focused to conduct a detailed analysis of S.Bingipura solid waste landfill site to fulfill the following objectives:

- Assessment of quality of water bodies surrounding S.Bingipura
- To determine the nature of soil around the landfill site.
- Also compared the soil characteristics for contaminated and uncontaminated soil in the study area.

II. MATERIALS AND METHODS

2.1. Description of the Study Area

Bangalore is also known as the silicon valley of India. Bangalore urban district is located on the Deccan Plateau in the south eastern part of Karnataka. Bangalore district lies between $12^0$39’ to $13^0$18’ North Latitude and $77^0$22’ to $77^0$52’ East Longitude. The temperature in the district is known to vary between 39^0C (Max.) to 11^0C (Min.). The average rainfall in the district is found to be 831mm. The district comprises of the following river: Shimsha, Kanva, Arkavathi, South Pennar and Vrishabhavathi. Total geographical area of the district is 2196 sq.km. The city is situated at an elevation of 920m above MSL.

The district is spread across four Taluks; Bangalore North, Bangalore East, Bangalore South and Anekal. Bangalore is a hub for Information Technology, Biotechnology, Aerospace, & key knowledge based industries.

As per provisional reports of Census India, population of Bangalore in 2011 is 96, 21, 551; of which male and female are 50,22,661 and 45,98,890 respectively. The sex ratio of Bangalore is 916 females per 1000 males. The population density of Bangalore is 4,381 per sq.km. The Population growth of the city as per Census 2011 was found to be 47.18%.

The study was carried out at S.Bingipura. village located in the state of Karnataka as shown in Figure 2.1. The village lies in Bangalore Urban district and the block/tehsil is Anekal. S.Bingipura is situated about 21.30 km from the city, with an average height of about 915m above MSL. The study started in the month of January 2016, but presently the site is being closed down and they are proposing a park at the site. The site is known to receive 1.45 lakh tons quantity of waste from Bommanahalli BBMP zone area.

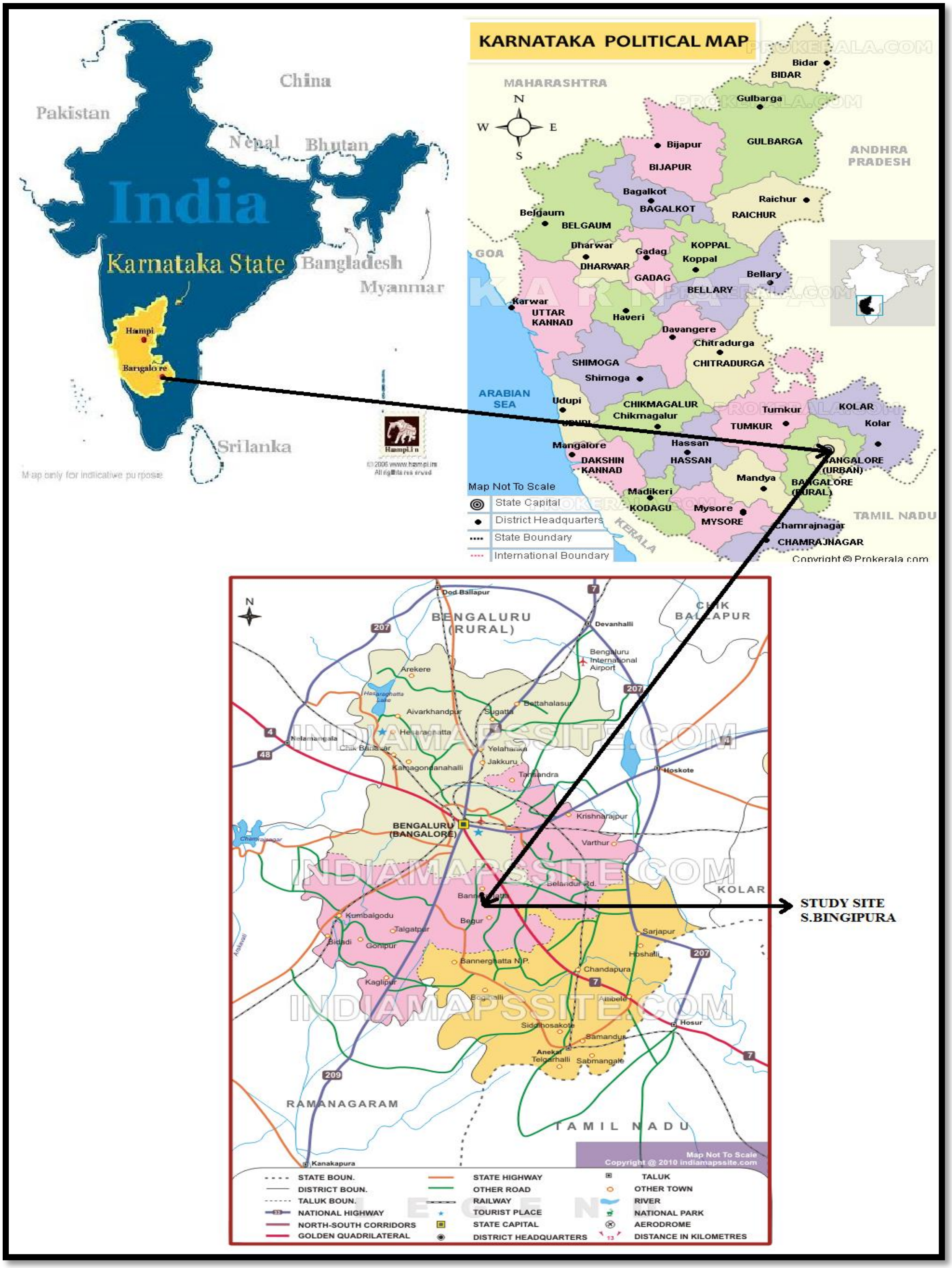

Fig.2.1. Index map of the study site

2.2 Sampling and Analytical Methods

Since there is no proper solid waste treatment and disposal, at the dump yard, there is a possibility of contamination to soil and groundwater in and around the site. So, a soil sample from the dump yard and soil away from the dump yard are collected for testing and comparison. Similarly, to check whether the ground water is being contaminated or not, the ground water samples were collected from a neighboring area (5 km) and tested. Soil samples were collected from the dumpsite, by removing the surface debris and subsurface soil dug to a depth of about 30cm and 1m with a hand auger. 5 Kg of soil sample was taken into the sterile containers and labeled. The samples were carried to laboratory and analyzed for water and soil chemical properties. The analysis was done as per the standard methods. Various Physico-chemical parameters examined in water samples include, pH, electrical conductivity (EC), total dissolved solids (TDS), total alkalinity (TA), total hardness (TH), calcium, magnesium, potassium, iron, chlorides, turbidity, Nitrates. Similarly soil samples were tested for moisture content, specific gravity, density of soil,gradation of soil properties, bulk density, electrical conductivity (EC) .The results were compared with BIS standard limits. The sampling locations were located on map(Figure 2.2 and 2.3) with help of GPS and detail of the site is given in Table.2.2. The methods adopted for the various parameters of soil and water analysis is mentione in the Table-2.3 and 2.4.

Table-2.2. Details of the Sampling locations

Location	Code	Latitude	Longitude	Environmental Attribute
S Bingipur	LT1	$77^0$37'43.57" E	$12^0$50'6.71" N	Leachate quality
	LP1	$77^0$37'30.41" E	$12^0$50'5.63" N	Leachate quality
	L 1	$77^0$37'54.4224" E	$12^0$49'59.214" N	Surface Water sampling
	BW 1	$77^0$37'17.462" E	$12^0$50'25.7064" N	Ground water sampling
	BW 2	$77^0$37'18.64" E	$12^0$50'21.27"N	Ground water sampling
	BW 3	$77^0$37'57.2736" E	$12^0$50'30.0696" N	Ground water sampling
	BW 4	$77^0$37'55.1172" E	12^0 50'25.1592" N	Ground water sampling
	BW 5	$77^0$38'0.2364" E	$12^0$49'59.4948" N	Ground water sampling
	BW 6	77^0'37'42.4956" E	$12^0$49'55.3836"N	Ground water sampling
	BW 7	$77^0$37'16.8924" E	$12^0$49'11.9136" N	Ground water sampling
	SS1	$77^0$37'40.6056" E	$12^0$50'13.1964" N	Soil quality Sampling location
	SS2	$77^0$37'44.1588" E	$12^0$50'10.2558" N	Soil quality Sampling location
	SS3	$77^0$37'43.8888" E	$12^0$50'6.8676" N	Soil quality Sampling location
	SS4	$77^0$37'53.9688" E	$12^0$49'13.2248"N	Soil quality Sampling location
	SS5	$77^0$37'47.4816" E	$12^0$49'5.2532" N	Soil quality Sampling location

Fig 2.2 Water Sampling locations

Fig 2.3 Soil Sampling locations

Table-2.3.The Methods of water and leachate Analysis

Sl.No	Parameter	Unit	Method adopted
1	Color	Hazens	Tintometer
2	Turbidity	NTU	Nephleometer
3	pH value	-	Digital pH meter
4	Conductivity	µS/cm	Conductivity meter
5	Total dissolved Solids	mg/l	Filter paper method
6	Suspended solids	mg/l	Filter paper method
7	Total solids	mg/l	Oven drying method
8	Total Hardness as CaCO3	mg/l	EDTA method
9	Calcium Hardness as CaCO3	mg/l	EDTA method
10	Magnesium Hardness as MgCO3	mg/l	EDTA method
11	Total Alkalinity as CaCO3	mg/l	Titration
12	Acidity	mg/l	Titration
13	Chlorides as Cl-	mg/l	Aginometric Titration
14	Sulphates as SO42-	mg/l	Flame Photometer
15	Nitrates as NO3-	mg/l	Titration
16	Fluorides as F-	mg/l	Ion Analyzer
17	Sodium	mg/l	Flame Photometer
18	Potassium	mg/l	Flame Photometer

Sl.No	Parameter	Unit	Method adopted
19	Ammonia	mg/l	Titration
20	Iron as Fe	mg/l	Spectro-photometer
21	DO	mg/l	Winkler's method
22	BOD	mg/l	Dilution method
23	COD	mg/l	Autoclave method
24	Lead	mg/l	Absorption Spectro-photometer
25	Nickel	mg/l	Absorption Spectro-photometer
26	Cadmium	mg/l	Absorption Spectro-photometer
27	Manganese	mg/l	Absorption Spectro-photometer
28	Zinc	mg/l	Absorption Spectro-photometer

Table-2.4. Tests on Soil

Sl.No.	Parameters	Method adopted
1	pH	Digital pH meter
2	Electrical Conductivity	Digital Conductivity meter
3	Bulk Density	Core cutter method
4	Dry Density	Core cutter method
5	Permeability	Constant head method
6	Moisture Content	Oven dry method
7	Specific Gravity	Pycnometer method

III. RESULTS AND DISCUSSIONS

The present paper mainly focused on identification of selected pollutants in the soil and ground water due to lechate generated from municipal solid waste landfill site.

3.1 Assessment of Ground water bodies

i. Colour : From Table.3.1. it was observed that the colour of the bore well samples are all less than 2, which falls under the desirable limit set by IS 10500:1991.

ii. Turbidity: From Table.3.1. it was observed that the amount of turbidity in the bore well samples varied from 0.5 NTU to 0.7 NTU, which is less than the desirable limit set by IS 10500:1991. Results depicts the variation of turbidity in the ground water samples

iii. pH : From Table.3.1. it was observed that the pH of the bore well samples varies from 7.72 to 8.19, which falls under the desirable limit set by IS 10500:1991. It was observed that the variation of pH in the ground water samples.

iv. Conductivity From Table.3.1. it was observed that the conductivity of the bore well samples varies from 589 µS/cm to 1451 µS/cm. Conductivity so high implies that the water sample is in fact contaminated.

v. Total Dissolved Solids, Suspended Solids and Total Solids From Table.3.1. it was observed that the TDS in the bore well samples varied from 390 mg/l to 930 mg/l, which is lower than the desirable limit set by IS 10500:1991. The amount of SS present is nil. Hence the TS also varies from 390 mg/l to 930 mg/l.

vi. Total Hardness, Calcium Hardness and Magnesium Hardness From Table.3.1. it was observed that the Total Hardness in the bore well samples varied from 380.11 mg/l to 171.23 mg/l, which is mostly under the desirable limit but under the permissible limit set by IS 10500:1991. BW-3 has total hardness more than the desirable limit. The Calcium Hardness varies from 252.50 mg/l to 95 mg/l while the Magnesium Hardness varies from 128 mg/l to 69.87 mg/l.

vii. Alkalinity and acidity From Table.3.1. it was observed that the alkalinity in the bore well samples varies from 308.80 mg/l to 183.45 mg/l. The alkalinity is greater than the desirable limit set by IS 10500:1991; for BW2(small amount), BW3 and BW4, whereas it falls under the desirable limit for the other samples From these results, it was observed that the acidity in the bore well samples varies from 2.36 mg/l to 1.07 mg/l..

viii. Chlorides From Table.3.1. it was observed that the amount of chlorides present in the bore well samples varied from 292.11 mg/l to 89.23 mg/l. BW3 has chlorides content more than desirable limit set by IS 10500:1991). The rest of the samples are found to have values within the desirable limit.

ix. Sulphates From Table.3.1. it was observed that the amount of sulphates present in the bore well samples varied from 99.11 mg/l to 31 mg/l, which falls under the desirable limit set by IS 10500:1991. Data depicts the variation of sulphates in the ground water samples.

x. Nitrates From Table.3.1. it was observed that the amount of nitrates present in the bore well samples varied from 15.24 mg/l to 7.11 mg/l, which falls under the desirable limit set by IS 10500:1991.

xi. Fluorides From Table.3.1. it was observed that the amount of fluorides present in the bore well samples varied from 0.42 mg/l to 0.24 mg/l, which falls under the desirable limit set by IS 10500:1991.

xii. Sodium From Table.3.1. it was observed that the amount of sodium present in the bore well samples varied from 144 mg/l to 56 mg/l.

xiii. Potassium From Table.3.1. it was observed that the amount of potassium present in the bore well samples varied from 8 mg/l to 4 mg/l.

xiv. Ammonia From Table.3.1. it was observed that the amount of ammonia present in BW 3 and BW5 samples was 0.24 mg/l and 0.12 mg/l respectively. The remaining samples had amount of ammonia below detection level (BDL).

xv. Iron From Table.3.1. it was observed that the iron content in the bore well samples varied from 0.15 mg/l to 0.07 mg/l, which is less than the desirable limit set by IS 10500:1991.

xvi. DO, BOD and COD From Table.3.1. it was observed that the amount of DO present in the bore well sample varied from 5.4 mg/l to 4.5 mg/l. Also, the amount of BOD present was found to be below detection level (BDL).

From Table.3.1. it was observed that the amount of COD present in the bore well sample varied from 4.89mg/l to 2.77 mg/l. Fig.4.16. depicts the variation of COD in the ground water samples.

Table 3.1.Ground water Assessment

Sl.No.	Test Parameters	Unit	BW1	BW2	BW3	BW4	BW5	BW6	BW7	IS 10500:1991	
										Desirable limit	Permissible limit
i	Colour	Hazen	< 2	< 2	< 2	< 2	< 2	< 2	< 2	5.00	25.00
ii	Turbidity	NTU	0.50	0.60	0.60	0.50	0.70	0.50	0.50	5.00	10.00
iii	pH	-	7.81	7.82	8.19	8.12	7.72	7.94	7.90	6.50-8.50	-
iv	Conductivity	µS/cm	664.00	760.00	1451.00	1327.00	612.00	589.00	1106.00	-	-
v	Total dissolved Solids	mg/l	420.00	510.00	930.00	850.00	390.00	390.00	690.00	500.00	2000.00
vi	Suspended solids	mg/l	< 1	< 1	< 1	< 1	< 1	< 1	< 1	-	-
vii	Total solids	mg/l	420.00	510.00	930.00	850.00	390.00	390.00	690.00	-	-
viii	Total Hardness as $CaCO_3$	mg/l	204.14	190.10	380.11	328.05	175.10	171.23	284.41	300.00	600.00
ix	Calcium Hardness as $CaCO_3$	mg/l	197.50	105.25	252.50	227.50	95.00	101.35	197.50	-	-
x	Magnesium Hardness as $MgCO_3$	mg/l	78.99	84.35	128.00	100.50	79.75	69.87	87.91	-	-
xi	Total Alkalinity as $CaCO_3$	mg/l	196.21	201.00	298.40	308.80	195.20	183.45	249.10	200.00	600.00
xii	Acidity	mg/l	1.07	1.75	2.36	1.79	1.20	1.12	1.42	-	-
xiii	Chlorides as Cl^-	mg/l	98.12	129.10	292.11	241.20	101.00	89.23	186.00	250.00	1000.00
xiv	Sulphates as SO_4^{2-}	mg/l	58.10	53.14	99.11	87.11	31.00	39.12	74.56	200.00	400.00
xv	Nitrates as NO_3^-	mg/l	7.11	12.10	15.24	12.14	8.23	9.01	10.24	45.00	-
xvi	Fluorides as F	mg/l	0.27	0.38	0.42	0.39	0.34	0.24	0.35	1.00	-
xvii	Sodium	mg/l	60.00	86.00	144.00	133.00	57.00	56.00	104.00	-	-
xviii	Potassium	mg/l	7.00	6.00	8.00	6.00	5.00	4.00	5.00	-	-
xix	Ammonia	mg/l	BDL	BDL	0.24	BDL	0.12	BDL	BDL	-	-
xx	Iron as Fe	mg/l	0.07	0.12	0.15	0.10	0.09	0.11	0.09	0.30	1.00
xxi	DO	mg/l	5.20	5.10	4.50	4.80	4.90	5.40	4.90	-	-
xxii	BOD	mg/l	BDL	BDL	BDL	BDL	BDL	BDL	BDL	-	-
xxiii	COD	mg/l	2.87	2.77	4.89	3.54	3.49	2.78	2.78	-	-

- BW1, BW2, BW3, BW4, BW5, BW6 and BW7 are Ground Water Samples
- BDL- Below Detective Level

3.2. Assessment of Surface water bodies

i. Colour From Table.3.2. it was observed that the colour of the lake sample was 4 Hazens, which falls under the desirable limit set by IS 10500:1991.

ii. Turbidity From Table.3.2. it was observed that the amount of turbidity in the lake sample was 21 NTU, which is more than the desirable limit set by IS 10500:1991. This may be due to the blown away leaves, sand, and also due to the villagers washing their clothes and cattle over the banks of the lake. The lake is also used by the commoners for bathing.

iii. pH From Table.3.2. it was observed that the pH of the lake sample was 7.96, which falls under the desirable limit set by IS 10500:1991.

iv. Conductivity From Table.3.2. it was observed that the conductivity of the lake sample was 3526 µS/cm. Conductivity so high only implies that the water sample is infact contaminated. This could be due to the possibility of the leachate to infiltrate through the soil and reach the lake and also other sources of pollution.

v. Total Dissolved Solids, Suspended Solids and Total Solids From Table.3.2. it was observed that the TDS, SS and TS present in the lake sample was 2270 mg/l, 50 mg/l and 2320 mg/l respectively, which is more than the desirable limit, set by IS 10500:1991.

vi. Total Hardness, Calcium Hardness and Magnesium Hardness From Table.3.2. it was observed that the Total Hardness, Calcium Hardness and Magnesium Hardness present in the lake sample was 320m mg/l, 190 mg/l and 130 mg/l respectively, which is greater than the desirable limit but under the permissible limit set by IS 10500:1991.

vii. Alkalinity and acidity From Table.3.2. it was observed that the alkalinity and acidity of the lake sample was 718.5 mg/l and zero respectively. The alkalinity is greater than both the desirable limit and the permissible limit set by IS 10500:1991.

viii. Chlorides From Table.3.2. it was observed that the amount of chlorides present in the lake sample was 723 mg/l, which is greater than the desirable limit but it falls under the permissible limit set by IS 10500:1991.

ix. Sulphates From Table.3.2. it was observed that the amount of sulphates present in the lake sample was 189 mg/l, which falls under the desirable limit set by IS 10500:1991.

x. Nitrates From Table.3.2. it was observed that the amount of nitrates present in the lake sample was 29 mg/l, which falls under the desirable limit set by IS 10500:1991.

xi. Fluorides From Table.3.2. it was observed that the amount of fluorides present in the lake sample was 0.78 mg/l, which falls under the desirable limit set by IS 10500:1991.

xii. Sodium From Table.3.2. it was observed that the amount of sodium present in the lake sample was 600 mg/l.

xiii. Potassium From Table.3.2. it was observed that the amount of potassium present in the lake sample was 41 mg/l.

xiv. Ammonia From Table.3.2. it was observed that the amount of ammonia present in the lake sample was 21.9 mg/l.

xv. Iron From Table.3.2. it was observed that the iron content in the lake sample was 0.46 mg/l, which is above the desirable limit but falls under the permissible limit set by IS 10500:1991.

xvi. DO, BOD and COD From Table.3.2. it was observed that the DO, BOD and COD of the lake sample was 0.8 mg/l, 34 mg/l and 187.14mg/l respectively, which is below the desirable limit set by IS 10500:1991.

Table.3.2. Bingipura Lake Assessment

Sl.No.	Test Parameters	Unit	L1	IS 10500:1991	
				Desirable limit	Permissible limit
i	Colour	Hazen	4.00	5.00	25.00
ii	Turbidity	NTU	21.00	5.00	10.00
iii	pH	-	7.96	6.50-8.50	-
iv	Conductivity	µS/cm	3526.00	-	-
v	Total dissolved Solids	mg/l	2270.00	500.00	2000.00
vi	Suspended solids	mg/l	50.00	-	-
vii	Total solids	mg/l	2320.00	-	-
viii	Total Hardness as $CaCO_3$	mg/l	320.00	300.00	600.00
ix	Calcium Hardness as $CaCO_3$	mg/l	190.00	-	-
x	Magnesium Hardness as $MgCO_3$	mg/l	130.00	-	-
xi	Total Alkalinity as $CaCO_3$	mg/l	718.50	200.00	600.00
xii	Acidity	mg/l	BDL	-	-
xiii	Chlorides as Cl^-	mg/l	723.00	250.00	1000.00
xiv	Sulphates as SO_4^{2-}	mg/l	189.00	200.00	400.00
xv	Nitrates as NO_3^-	mg/l	29.00	45.00	-
xvi	Fluorides as F	mg/l	0.78	1.00	-
xvii	Sodium	mg/l	600.00	-	-
xviii	Potassium	mg/l	41.00	-	-
xix	Ammonia	mg/l	2.19	-	-
xx	Iron as Fe	mg/l	0.46	0.30	1.00
xxi	DO	mg/l	0.8	-	-
xxii	BOD	mg/l	34.00	-	-
xxiii	COD	mg/l	187.14	-	-

3.2. Assessment of soil parameters

The soils in Bangalore city are mainly lateritic soil and red fine loamy to clayey soils. Red loamy soils generally occur on hilly and undulating land slope on granite and gneissic terrain. It is mainly seen in eastern and southern parts of Bangalore. Laterite soil is usually found in Anekal taluk and western parts of Bangalore North and South taluks. The results of soil analysis are tabulated in Table.3.3. It was observed from the Table 3. that the color parameter of soil near the dumping location SS1,SS2 and SS3 is dark brown to dark black. Hence an attempt has made to collect two more sample viz one at the contaminated soil at the dumping site itself and other one is 2 km away from the land fill site. The analysed results are depicted in Table 3.4.

Table.3.3. Tests on Soil

Sl. No.	Parameter	Study Site				
		SS 1	SS 2	SS 3	SS 4	SS 5
1	Colour	Dark Brown	Dark Brown	Black	Light Brown	Light Brown
2	pH	7.18	7.25	8.46	7.15	7.20
3	Electrical Conductivity, /Ω/cm	1.00	0.80	3.20	0.10	0.30
4	Moisture Content, %	10	11	13	12	13
5	Specific Gravity	2.44	2.46	2.33	2.35	2.37
6	Field Density, g/cm^3	1.38	1.44	1.56	1.81	1.74
7	Dry Density, g/cm^3	1.25	1.29	1.38	1.61	1.53
8	Dry Unit Weight, kN/m^3	12.26	12.65	13.53	15.79	15.01
9	Permeability, cm/hr	2.5 to 5 Moderate	2.5 to 5 Moderate	2.5 to 5 Moderate	2.5 to 5 Moderate	2.5 to 5 Moderate

Experimental results obtained on effect of municipal solid waste lechate on the characteristics of soil on both contaminated and uncontaminated soil presented in Table 3.4. The present paper also focused on identification of selected pollutants in the soil due to lechate generated from municipal solid waste landfill site and uncontaminated soil to serve as control. Finally comparison of both contaminated and uncontaminated soil characteristics was made

Table.3.4. Quality of soil Parameters estimated in contaminated and uncontaminated soils

Sl No	Parameters	Contaminated Soil(SS1)	Un contaminated Soil (SS5)
1	Moisture Content	14%	11%
2	Specific Gravity	2.437	2.37
3	Particle Size Distribution		

Sl No	Parameters	Contaminated Soil(SS1)	Un contaminated Soil (SS5)
	Uniformity coefficient	Cu= 5.5	Cu= 8.57
	Curvature coefficient	Cc= 2.36	Cc= 3.07
4	Permeability	0.62 Cm/S	0.069 Cm/S
5	Shear Strength	13.5 Kn/Sq M	13 Kn/ Sq M
6	Compressibility	0.82 Sqm/ Kn	1 Sqm/ Kn
7	pH	7.20	8.00
8	Chloride	108.46 Mg/L	40mg/L
9	Alkalinity	83 Mg/L As Caco3	236 Mg/L As Caco3

3.2.1. Natural Moisture Content of contaminated and uncontaminated soil The results show that the values of the Natural Moisture Content of the Uncontaminated soil is lower compared to those of the contaminated soil samples. This trend could attribute reason that the contaminated soil is expected to be damper, since the natural ground level is covered by the MSW, thereby preventing direct evaporation of moisture from the soil below.

3.2.2. Specific gravity of contaminated and uncontaminated soil The results show that, the values of the specific gravity of the contaminated soil was higher than the uncontaminated soil. It could be attributed that the specific gravity of contaminated soil is higher because of the higher moisture content of the contaminated soil as compared to uncontaminated soil.

3.2.3. Particle Size Distribution of contaminated and uncontaminated soil From the Table 3.1 the uncontaminated soil is relatively homogeneous and contaminated soil has more fines than the uncontaminated soil. The higher percentage of fine content recorded for the contaminated soil can be attributed to the fines emanating from the decomposed MSW above the soil. Also during bacterial degradation or decomposition of MSW large amount of fines are produced.

3.2.4. Permeability Test of contaminated and uncontaminated soil Laboratory falling head method was used in the determination of the coefficient of permeability of the soils. From the results, the contaminated soil has higher values of coefficient of permeability than the uncontaminated soils. These results somehow contradict the fact that the contaminated soil particles are loosely arranged which would have ordinarily increased the pore space in the soil. This anomaly may be due to particles flocculation as a result of contamination with MSW. The flocculation process may have altered the behaviours of the fine particles from clay-like to silt-like and consequently, making the soil more permeable.

3.2.5. Shear Strength Test Contaminated and Uncontaminated Soil The shear strength parameters were determined by undrained triaxial test using undisturbed soil samples. From the results, the shear strength value is higher in case of contaminated soil than those recorded for the uncontaminated soil. The relatively high value recorded for contaminated soil samples a result of pseudocohesion, brought about by leachate from the decomposing MSW. This may be due to particle flocculation as a result of contamination with MSW.

3.2.6. Compressibility Test of contaminated and uncontaminated soil Consolidation test on the undisturbed samples was use to investigate the effect of the MSW on the compressibility characteristics of the soils. The results show that the contaminated soil has relatively lower values than uncontaminated soil. The lower values obtained for contaminated soil in comparison with the values obtained for uncontaminated soil, can be attributed to the soil immediately beneath the MSW don't undergoing any compression as a result of the weight of the MSW above.

3.2.7. pH of contaminated and uncontaminated soil We can conclude that, pH value of uncontaminated soils is higher than the contaminated soils. The pH of the contaminated soils is 7.20, it signifies that it is slightly acidic in nature compared to uncontaminated soil could be reason behind that the nature of the solid waste contribute acidity of the soil. Due to this reason the pH of contaminated soil is slightly acidic than uncontaminated soils. Alkalinity value of uncontaminated soils is higher than the contaminated soils. This could be the reason that the pH of the contaminated soil is slightly acidic than uncontaminated soil.

3.2.8. Chloride of contaminated and uncontaminated soil The chloride concentration in contaminated soil is 108.46 mg/l where as uncontaminated is 40 mg/l, it indicates that it is higher than uncontaminated soil. This contribute due to disposal of solid waste, the quality of the soil is reduced and it clearly indicated by the chloride values of contaminated soils.

3.2.9. Alkalinity of contaminated and uncontaminated soil The alkalinity concentration in contaminated soil is 83 mg/l as caco3 where as uncontaminated is 236 Mg/L As Caco3, it indicates that it is lower than uncontaminated soil. This clearly indicated by the lesser alkalinity values of contaminated soils due to acidic properities due to the concentration of leachate.

The results of contaminated and uncontaminated soils are represented in Table 3.4. The result in the table indicates that except for pH and alkalinity, all other parameters are higher in contaminated soil compared to uncontaminated soils. The study concludes based on the results obtained, the disposal site soil quality is reduced compared to uncontaminated soil. In other words, due to the disposal of solid waste on land the soil quality gets reduced.

IV. CONCLUSION

The following conclusions has been drawn based on the results obtained in the present study.

- The surface water sample is found to have significantly high salinity and alkalinity as reflected in their values for conductivity, TDS, alkalinity and pH. Hence it indicating that the surface water body is polluted.
- Test result on ground water concluded that certain bore well on the down stream side were polluted.
- The Analysis of the soil samples around the site shows that the soil has moderate permeability.
- Also Based on the experiment results obtained from the soil sample analysed in both contaminated and uncontaminated soils following major conclusions have been drawn.
    - The coefficient of permeability of the contaminated soil has higher than the uncontaminated soils. This indicates that due to disposal of solid waste the quality of the soil is reduced and it clearly indicated by the chloride values of contaminated soils.
    - Study conclude based on the results obtained, the disposal site soil quality is reduced compared to uncontaminated soil. In other words, due to the disposal of solid waste on land the soil quality gets reduced.

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